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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/627,228	07/25/2003	Farhad K. Moghadam	A7632/T49100	2446

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EXAMINER	
MCDONALD, RODNEY GLENN	
ART UNIT	**PAPER NUMBER**
1753	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	02/28/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	10/627,228	MOGHADAM ET AL.	
	Examiner	Art Unit	
	Rodney G. McDonald	1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 January 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-29* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-29* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on January 16, 2007 has been entered.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1-13, 15, 18, 21, 22 and 25-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiang et al. (U.S. Pat. 6,428,859) in view of Sherman (U.S. Pat. 6,342,277), Chiang et al. (US PG Pub 2002/0197402) and Machida et al. (U.S. Pat. 4,732,761).

Regarding claim 1, Chiang et al. '859 teach a method of enhanced sequential atomic layer deposition (ALD) suitable for deposition of barrier layers, adhesion layers, seed layers, low dielectric constant (low-k) films, high dielectric constant (high-k) films, and other conductive, semi-conductive and non-conductive films. (See Abstract) The method comprises exposing the substrate to a first gaseous reactant allowing a monolayer of the reactant to form on the surface. The monolayer is adsorbed onto the substrate. (Column 8 lines 25-27; Column 12 lines 56-58) The reactant is evacuated from the chamber. (Column 8 lines 33-35; Column 12 lines 59-60) The monolayer is exposed to radicals while biasing the substrate to react with the monolayer to deposit the thin film. (Column 8 lines 36-56; Column 12 lines 65-68; Column 13 lines 1-6) The process is repeated until the desired film thickness is built up. (Column 8 lines 60-61)

Regarding claim 18, 22 and 25, Chiang et al. '859 teach that the reactants are adsorbed. (Column 5 lines 62-65)

The differences between Chiang et al. '859 and the present claims is that the first reactant and the second reactant is not discussed (Claims 1, 15), where the level of the applied bias is sufficient to cause sputtering is not discussed (Claims 1, 15), using thermal energy to drive the reaction is not discussed (Claim 1), wherein an average atomic mass of all atomic constituents in the second reactant is less than or equal to an

average atomic mass of oxygen is not discussed (Claims 2, 15), wherein the silicon-containing reactant is a silane family member having a formula of Si_nH_{2n+1} is not discussed (Claims 3, 15), wherein the second reactant consists of molecular oxygen is not discussed (Claim 4), wherein the second reactant consists of molecular oxygen and a sputtering agent is not discussed (Claims 5, 21, 26), wherein the sputtering agent consists of molecular hydrogen is not discussed (Claims 6, 21, 26), wherein the sputtering agent comprises molecular hydrogen and/or helium is not discussed (Claims 7, 21, 26), where the oxygen radicals are generated by forming a plasma within the chamber is not discussed (Claim 8), where the oxygen radicals are generated by forming a plasma in a remote plasma chamber is not discussed (Claim 9), wherein the chamber is evacuated of the silicon containing reactant prior to exposing the substrate to oxygen radicals is not discussed (Claim 10), wherein the chamber is purged of the silicon-containing reactant by flowing a gas that is chemically inert to silica glass into the chamber is not discussed (Claim 11), wherein the chamber is purged of the silicon-containing reactant by flowing an oxygen source into the chamber is not discussed (Claim 12), wherein energy is applied to the chamber to form a plasma from the second reactant while biasing the substrate and wherein no plasma is formed while the substrate is exposed to the silicon-containing reactant is not discussed (Claim 13), forming the film over a substrate having a gap between two adjacent raised features is not discussed (Claims 15, 29), the temperature of the substrate is not discussed (Claims 15, 27, 28) and the sputtering effect causing the silica film to grow up from the

bottom surface of the gap at a rate greater than it grows inward on the sidewall surface of the gap is not discussed (Claim 29).

Regarding the first reactant and the second reactant (Claims 1, 15), Sherman teaches a process for growing a thin film including a plurality of cycles, wherein at least one cycle comprises exposing a part to a gaseous first reactant, including an element of the thin film to be formed, wherein at least a portion of the first reactant adsorbs on the part; purging the chamber of the gaseous first reactant; converting the portion of the first reactant adsorbed on the part to either an element or compound by exposing the part to a gaseous second react that includes radicals created by a plasma discharge, whereby a thin film is formed; and purging the chamber of the gaseous second reactant. (Column 12 lines 54-64) The first and second reactants for forming silica glass are silane and oxygen. (Column 8 lines 38-51)

Regarding where the level of the applied bias is sufficient to cause sputtering (Claims 1, 15), Chiang et al. '859 discussed above teach applying a bias of -20V to -500 V during radical exposure. The Examiner asserts that the higher end of the range causing sputtering. Chiang et al. '859 teach that oxygen and/or radicals can effect etching. (Chiang et al. '859 Column 12 lines 33-52) Furthermore, Chiang et al. '402 recognize that values over |-150V| will cause sputtering. (See Paragraph 0046) Furthermore, Machida et al. recognize that in a second step of CVD that a bias voltage should be applied to cause sputtering to fill openings in a substrate. (See Abstract; Column 9 lines 4-7, lines 11-21, lines 30-45)

Regarding wherein an average atomic mass of all atomic constituents in the second reactant is less than or equal to an average atomic mass of oxygen (Claims 2, 15), Sherman teach that the second reactant can be oxygen which would be equal to the average atomic mass of oxygen. (Column 8 lines 38-51)

Regarding wherein the silicon-containing reactant is a silane family member having a formula of Si_nH_{2n+1} (Claims 3, 15), Sherman teach that first reactant can be silane. (Column 8 lines 38-51)

Regarding wherein the second reactant consists of molecular oxygen (Claim 4), Sherman teach that the second reactant can be molecular oxygen. (Column 8 line 46)

Regarding wherein the second reactant consists of molecular oxygen and a sputtering agent (Claims 5, 21, 26), Chiang et al. '859 teach that the sputtering agent can be argon. (Column 8 lines 41-43) Chiang et al. '859 also teach oxygen can be used. (Column 12 lines 38-43) Sherman teach that oxygen can be used as the second reactant. (Column 8 lines 38-51) Machida et al. suggest that argon can be used as a sputtering agent. (See Abstract)

Regarding wherein the sputtering agent consists of molecular hydrogen (Claims 6, 21, 26), Chiang et al. '859 teach that molecular hydrogen can be used for etching. (Column 12 lines 34-51).

Regarding wherein the sputtering agent comprises molecular hydrogen and/or helium (Claims 7, 21, 26), Chiang et al. '859 teach that molecular hydrogen can be used for etching. (Column 12 lines 34-51)

Regarding where the oxygen radicals are generated by forming a plasma within the chamber (Claim 8), Sherman suggest forming oxygen radicals within the chamber. (Column 6 lines 36-41; Column 8 lines 38-51)

Regarding where the oxygen radicals are generated by forming a plasma in a remote plasma chamber (Claim 9), Chiang et al. '859 teach forming radicals in a remote plasma chamber. (Column 6 lines 39-50) Sherman suggests utilizing oxygen as the second reactant. (Column 8 lines 38-51)

Regarding wherein the chamber is evacuated of the silicon containing reactant prior to exposing the substrate to oxygen radicals (claim 10), Chiang et al. '859 teach exhausting the first reactant gas from the chamber prior to exposing the substrate to the second reactant. (Column 12 lines 55-68) Sherman teach the first react to be silane and the second reactant to be oxygen. (Column 8 lines 38-51)

Regarding wherein the chamber is purged of the silicon-containing reactant by flowing a gas that is chemically inert to silica glass into the chamber (Claim 11), Sherman teach utilizing an inert gas between exposure of the reactant gases. (Column 7 lines 55-61)

Regarding wherein the chamber is purged of the silicon-containing reactant by flowing an oxygen source into the chamber (Claim 12), Sherman teach purging by utilizing the second reactant gas of oxygen. (Column 7 lines 61-65)

Regarding wherein energy is applied to the chamber to form a plasma from the second reactant while biasing the substrate and wherein no plasma is formed while the substrate is exposed to the silicon-containing reactant (Claim 13), Chiang et al. '859

teach biasing the substrate while utilizing the second reactant. (Column 8 lines 36-55) Sherman teach forming a plasma from the second reactant by utilizing an RF coil. (Sherman Column 6 lines 35-41) Chiang et al. '859 teach forming no plasma during first reactant deposition at a temperature of less than 350 degrees C. (Column 8 lines 25-31)

Regarding forming the film over a substrate having a gap between two adjacent raised features (Claims 15, 29), Sherman teach filling a gap having two adjacent raised features. (Column 11 lines 42-46)

Regarding the temperature of the substrate and using thermal energy (Claims 1, 15, 27 and 28), Chiang et al. ' 859 teach that the temperature of the substrate can be less than 350 degrees C which overlaps applicants claimed range of 300-600 Degrees C. (Column 8 lines 30-32)

The motivation for utilizing the elements of Sherman is that it allows for depositing a conformal layer of uniform thickness. (Column 5 lines 22-24)

Regarding the sputtering effect causing the silica film to grow up from the bottom surface of the gap at a rate greater than it grows inward on the sidewall surface of the gap (Claim 29), Machida et al. teach growing a silica film at a rate greater from the bottom than of the sidewalls. (Column 9 lines 3-10)

The motivation for utilizing the features of Machida et al. is that it allows for planarization. (See abstract)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Chiang et al. '859 as taught by utilizing

the elements of Sherman and the particular bias as taught by Chiang et al. '859 further evidenced by Chiang et al. '402 and Machida et al. because it allows for depositing a conformal layer of uniform thickness.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chiang et al. '859 in view of Sherman, Chiang et al. '402 and Machida et al. as applied to claims 1-13, 15, 18, 21, 22 and 25-29 above, and further in view of Qian et al. (U.S. Pat. 5,571,576).

The difference not yet discussed is the doping of the silica glass film with a dopant. (Claim 14).

Regarding Claim 14, Qian et al. teach providing a fluorine-containing gas in order to dope a silicon oxide dielectric layer. (See Abstract)

The motivation for doping the silicon oxide film with fluorine is that it allows production of a film with a low dielectric constant, having all the necessary film properties such as stability, density, gap fill, low film stress and step coverage. (Column 1 lines 51-55)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have doped a silicon oxide film as taught by Qian et al. because it allows for production of a film with a low dielectric constant, having all the necessary film properties such as stability, density, gap fill, low film stress and step coverage.

Claim 16, 17, 19, 20, 23 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiang et al. '859 in view of Sherman, Chiang et al. '402 and

Machida et al. as applied to claims 1-13, 15, 18, 21, 22 and 25-29 above, and further in view of Grimbergen et al. (U.S. Pat. 6,406,924).

The difference not yet discussed is the monitoring and stopping the deposition when full oxidation has occurred (Claims 16, 19 and 23) and the endpoint converting (Claims 17, 20 and 24)

Regarding claims 16, 19, 23, Grimbergen et al. teach monitoring a characteristic feature (i.e. oxidation) and stopping deposition when the characteristic feature matches a stored characteristic feature. (Column 19 lines 40-58)

Regarding claims 17, 20, 24, Grimbergen et al. teach detecting radiation reflected form the substrate and comparing the reflected radiation to stored reflected information and utilizing the signal to determine an endpoint. (Column 19 lines 40-58)

The motivation for utilizing monitoring means is that it allows for ending the process. (Column 19 lines 40-58)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have monitored during deposition as taught by Grimbergen et al. because it allows for ending the process at a particular time.

Response to Arguments

Applicant's arguments filed February 27, 2007 have been fully considered but they are not persuasive.

CLAIM 1 (and its dependents):

In response to the argument that Chiang et al. '859 uses kinetic energy associated with high energy ion bombardment rather than thermal energy to drive its

deposition reaction, it is argued that Chiang et al. '859 teach both a bias and temperature which overlaps Applicant's temperature range (i.e. 300-350 degrees C). It is the Examiner's position that since the conditions of Chiang et al. '859 are the same as Applicant's (i.e. the same bias and temperature conditions) that the temperature would provide activation energy to drive the deposition reaction. While it is Applicant's position that the thermal energy is the primary driving force behind the reaction it is argued that since the bias and the temperature conditions of Chiang et al. '859 are the same as Applicant's the thermal energy would drive the reaction. (See Chiang et al. '859 discussed above)

CLAIM 2 (and its dependents):

In response to the argument that the prior art does not teach the limitation of the average atomic mass of all atomic constituents introduced into the chamber during the converting step is less than or equal to an average atomic mass of oxygen, it is argued that Sherman suggest that in the step of converting oxygen can be introduced which would be equal to the atomic mass of oxygen. While Applicant has argued that the combination of Chiang et al. '859 and Sherman would use both inert gas and oxygen it is the Examiner's position that since Sherman suggest utilizing oxygen for the conversion step that one of ordinary skill in the art would substitute the inert gas with oxygen in order to convert the reactant to a silica film. (See Chiang et al. '859 and Sherman discussed above)

CLAIM 15 (and its dependents):

In response to the argument that the prior art of record does not teach the silica glass film growing up from the bottom surface of the gap at a rate greater than it grows inward on the sidewall surface of the gap, it is argued that Machida et al. teach that by controlling the bias the silica film can be grown up form the bottom surface of the gap at a rate greater than it grows inward on the sidewall surface of the gap. (See Machida et al. discussed above)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rodney G. McDonald whose telephone number is 571-272-1340. The examiner can normally be reached on M- Th with Every other Friday off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam X. Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Rodney G. McDonald
Rodney G. McDonald
Primary Examiner
Art Unit 1753

RM
February 27, 2007